



2021 Astro MDEX and MO Preproposal Conference NASA's Space Communication and Navigation Program (SCaN)

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Lunar Exploration Ground Segment (LEGS)

Opportunity to explore commercial capability and willingness to contribute to LEGS capability

The LEGS mission is to provide direct-to earth communication and navigation services for missions operating from 36,000 kilometers (km) in the GEO to cis-Lunar and other orbits out to 2 Million km.

To fully support distant orbits there will be three LEGS sites equally spaced around the Earth.

Needs:

- S-, X-, and Ka-band – forward and return for all bands, S&Ka or X&Ka simultaneous links
- 18m class EIRP and G/T performance
- Services to include TT&C, Forward and Return Data, Radiometric Tracking and Antenna Auto Tracking Angles
- From a spacecraft perspective LEGS will be compatible with DSN 34m subnet
- From a operations center perspective LEGS will be integrated with the Near Space Network (NSN), not Deep Space Network (DSN)

LEGS Functional & Performance Requirements

RF Band	Lower Limit	Upper Limit
S-band Forward	2025 MHz	2120 MHz
S-band Return	2200 MHz	2300 MHz
X-band Forward	7145 MHz	7235 MHz
X-band Return	8400 MHz	8500 MHz
Ka-band Forward	22.55 GHz	23.15 GHz
Ka-band Return	25.5 GHz	27.0 GHz

Function	Performance
Transmit and Receive Polarizations	Tx: RHC or LHC, Rcv: RHC & LHC
Antenna Travel Range	>360 deg Azimuth Continuous (TBR) 0-90 deg Elevation
Antenna axis Tracking rate	0.5 deg/s velocity (TBR)
Radiometric Tracking	Per CCSDS 414.1-B-2, Pseudo-Noise (PN) Ranging Systems
Radiometric Accuracy	Equivalent to DSN adjusted to C/No
Autotrack Accuracy	+/- 0.2 dB of beam peak (TBR)
Multiple Spacecraft Per Antenna	Up to 4 simultaneous return services per Aperture (Max 3 Ka)
Timing Reference	Short term stability better than 10^{-14} (TBR)

RF Performance Criteria - Forward	S-band	X-band	Ka-Band
EIRP (min)	81 dBW	86 dBW	89 dBW
Approx. 3 dB Beamwidth	0.5 deg	0.1 deg	0.04 deg
Forward Distortions	1 dB max	1 dB max	1 dB max
Carrier Modulation	Direct PCM/PM PCM/PM/PSK, OQPSK, BPSK	Direct PCM/PM PCM/PM/PSK, OQPSK, BPSK	BPSK, OQPSK Filtered OQPSK
Max Data Rate	10 Msps	10 Msps	40 Msps

RF Performance Criteria - Return	S-band	X-band	Ka-Band
G/T (min)	28 dB/K	39 dB/K	47.5 dB/K
Approx. 3 dB Beamwidth	0.5 deg	0.1 deg	0.04 deg
Implementation Loss	2 dB max	2 dB max	2 dB max
Demodulation	Direct PCM/PM, PCM/PM/PSK, OQPSK, BPSK	Direct PCM/PM, PCM/PM/PSK, OQPSK, BPSK	OQPSK, Filtered OQPSK
Max Data Rate	20 Msps	150 Msps	500 Msps